

CONTEMPORARY METALLIC MATERIALS

Md Abdul Maleque
Iskandar Idris Yaacob
Zahurin Halim



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Edited by:

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Microstructure and Mechanical Properties of Neutron Transmutation Doped Silicon under Cf-252 Neutron Bombardment

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Abstract: Silicon substrates (silicon wafer) have been currently irradiated by californium-252 (Cf-252) isotopic neutron radioactive source. Instead of using neutron source from nuclear reactor, isotopic neutron source has been directly used to irradiate the silicon in order to obtain Neutron Transmutation Doped (NTD) silicon. In conjunction with NTD process, microstructure of irradiated silicon has been examined by using Field Emission Scanning Electron Microscope (FESEM) and the concentration of the impurities (Phosphorous) has been determined by Energy Dispersive Spectrometry (EDS) system. Surface morphology of rough microstructure was observed under FESEM for irradiated silicon and the hardness changes was measured by nanoindentation system. The increase of phosphorous impurities for irradiated silicon has been successfully identified via EDS.

Introduction

It is necessary to dope silicon with impurities in order to make possible current flow through the bulk of the silicon for the power devices. Traditionally, thermodynamics plays an important role since nearly all impurities tend to remain in the melt. In contrast, the role played by the thermodynamics is negligible for Neutron Transmutation Doped (NTD) that incorporated nuclear reactor [2-4]. Certainly, the irradiation-induced Phosphorous atoms are created by means of neutron capture by a ³⁰Si atom and forming the unstable ³¹Si isotope. This ³¹Si subsequently transmutes to ³¹P by β^- emission and indirectly create phosphorous-doped silicon.

A high density of defects created by the silicon atom after thermal-neutron captures as well as by the direct collisions of fast neutrons has been reported during the transmutation process by Abbaci et al. [1]. Using NTD method, phosphorus dopant will be uniformly distributed and will be also substituted in the lattice whereby it can act as a donor [2]. A few patents have been developed [2-3]. However most of the patents' methods utilised neutron emission from nuclear reactor as neutron source. In order to develop more economically and low risk irradiation facility for NTD process, isotopic neutron source Cf-252 has been used instead of nuclear reactor.